FIG. 1

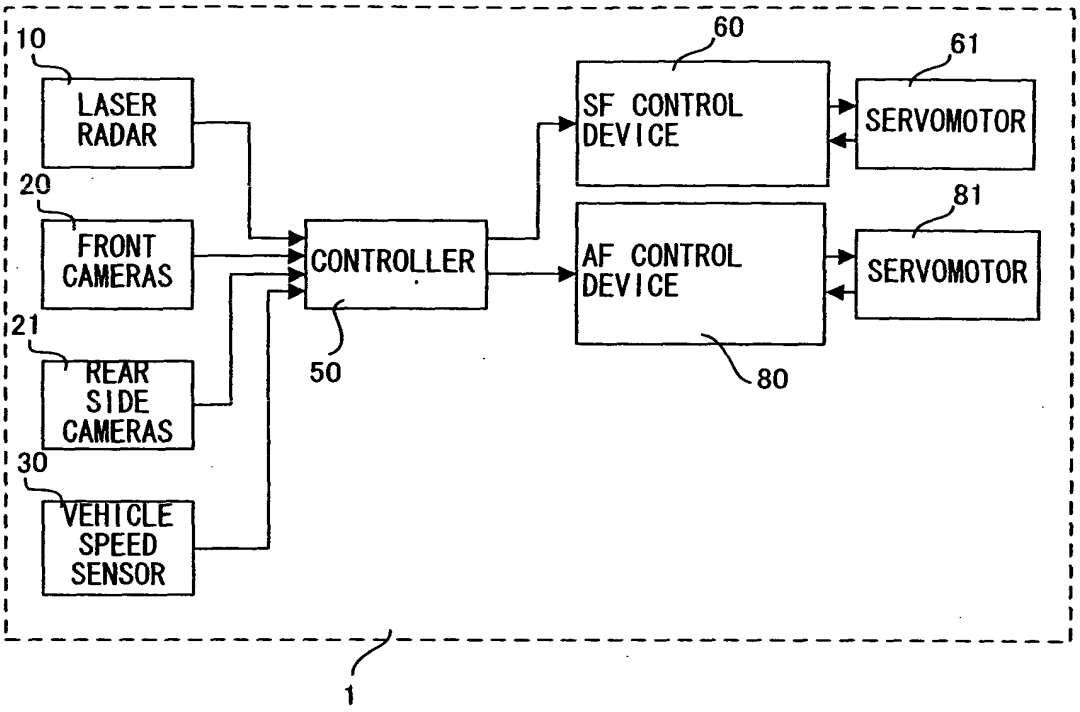

10
LASER RADAR
20
FRONT CAMERAS
21
REAR SIDE CAMERAS
30
VEHICLE SPEED SENSOR
CONTROLLER
50
60
SF CONTROL DEVICE
61
SERVOMOTOR
AF CONTROL DEVICE
80
81
SERVOMOTOR
1

FIG. 2

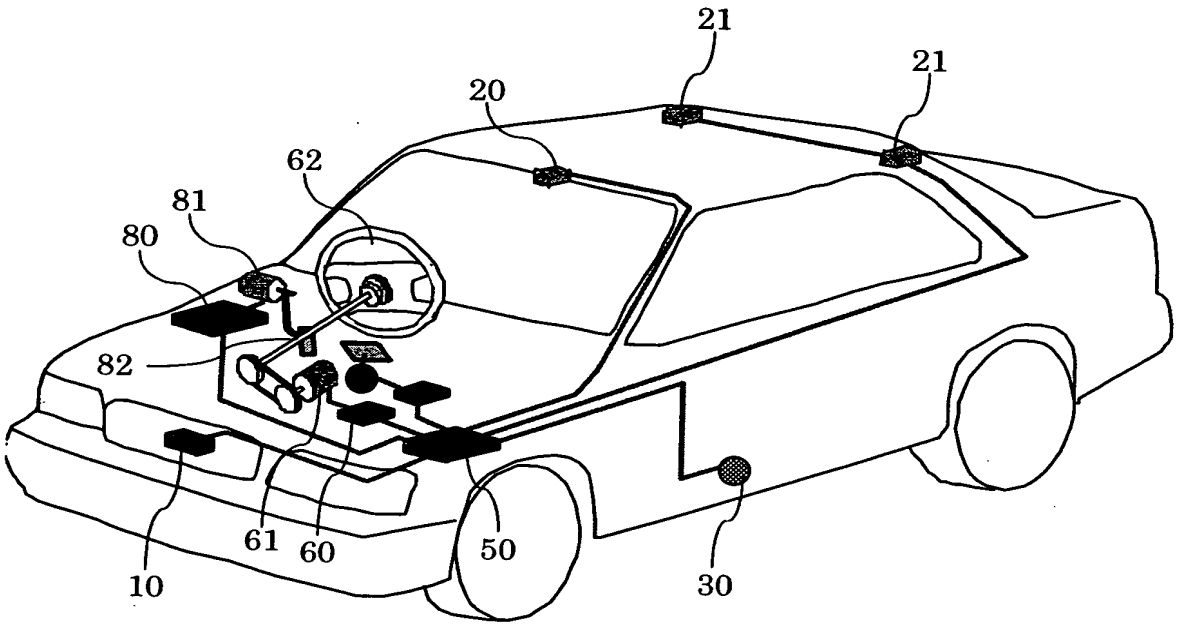


FIG. 3

	INFORMATION CONVEYANCE MODE BEFORE AND AFTER STATUS TARANSITION			OUTPUT TIMING FOR INFORMATION CONVEYANCE UPON STATUS TRANSITION				DESIGN PRINCIPLE
				LONGITUDINAL		LATERAL		
	BEFORE	→	AFTER	SIMULTANEOUS	DELAYED	SIMULTANEOUS	DELAYED	
A	NO INFORMATION		LONGITUDINAL	○				INFORMATION CORRESPONDING TO A SINGLE DIRECTION IS COMMUNICATED PROMPTLY
B	NO INFORMATION		LATERAL			○		INFORMATION CORRESPONDING TO A SINGLE DIRECTION IS COMMUNICATED PROMPTLY
C	LONGITUDINAL		NO INFORMATION	○				INFORMATION CORRESPONDING TO A SINGLE DIRECTION IS COMMUNICATED PROMPTLY
D	LATERAL		NO INFORMATION			○		INFORMATION CORRESPONDING TO A SINGLE DIRECTION IS COMMUNICATED PROMPTLY
E	NO INFORMATION		LONGITUDINAL + LATERAL	○			○	STEERING RESPONSE OPTIMIZED BY PROMPTING ACCELERATOR PEDAL OPERATION FIRST TO LOWER
F	LONGITUDINAL		LONGITUDINAL + LATERAL	○			○	STEERING RESPONSE OPTIMIZED BY PROMPTING ACCELERATOR PEDAL OPERATION FIRST TO LOWER
G	LATERAL		LONGITUDINAL + LATERAL	○			○	STEERING RESPONSE OPTIMIZED BY PROMPTING ACCELERATOR PEDAL OPERATION FIRST TO LOWER
H	LONGITUDINAL + LATERAL		NO INFORMATION		○	○		FREEDOM IN STEERING OPERATION IS FIRST INDICATED AND THEN ACCELERATOR PEDAL
I	LONGITUDINAL + LATERAL		LONGITUDINAL		○	○		FREEDOM IN STEERING OPERATION IS FIRST INDICATED AND THEN ACCELERATOR PEDAL
J	LONGITUDINAL + LATERAL		LATERAL		○	○		FREEDOM IN STEERING OPERATION IS FIRST INDICATED AND THEN ACCELERATOR PEDAL
K	LONGITUDINAL		LATERAL		○	○		NEW RISK IS FIRST INDICATED
L	LATERAL		LONGITUDINAL	○			○	NEW RISK IS FIRST INDICATED

FIG. 4

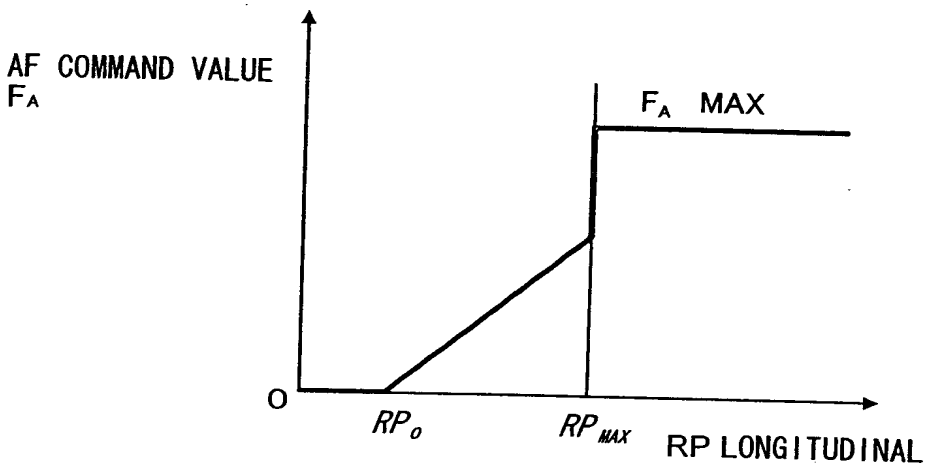
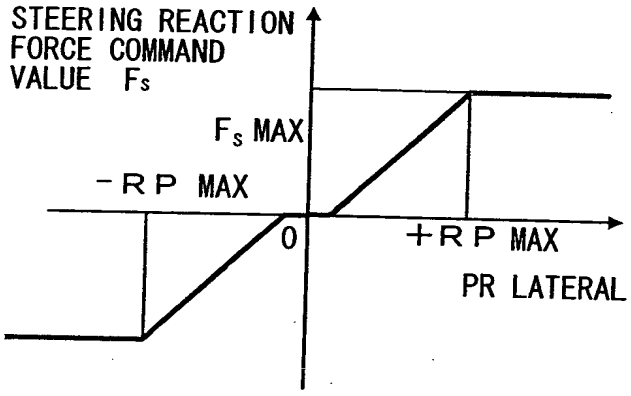

AF COMMAND VALUE
F_A
F_A MAX
O
RP_o
RP_{MAX}
RP LONGITUDINAL

FIG. 5


STEERING REACTION
FORCE COMMAND
VALUE F_S
F_S MAX
-RP MAX
0
+RP MAX
PR LATERAL

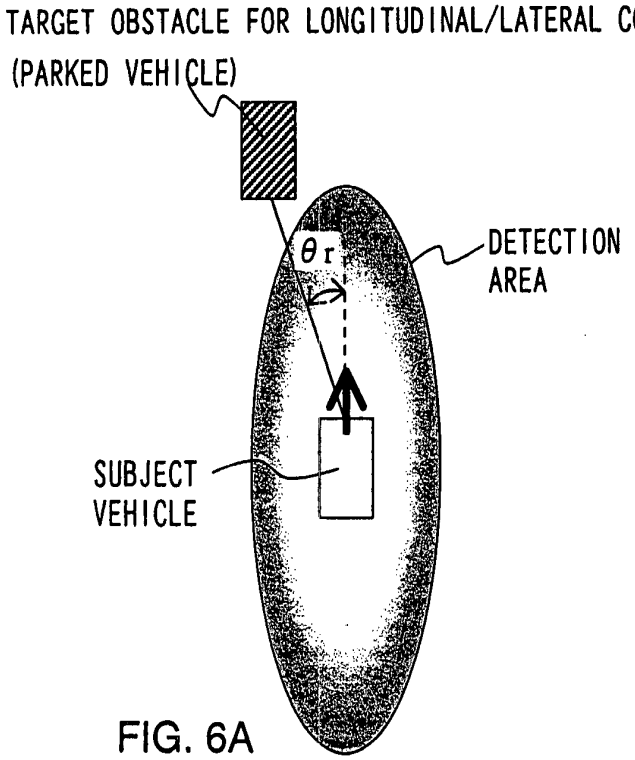


FIG. 6A

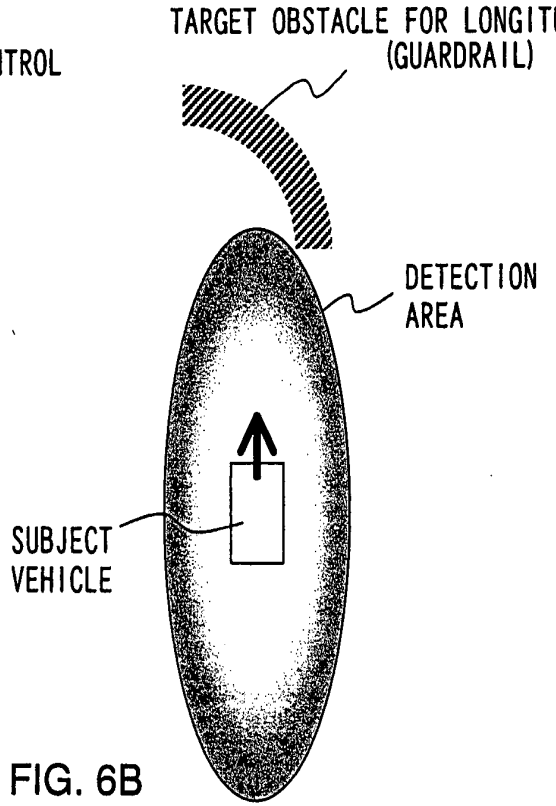


FIG. 6B

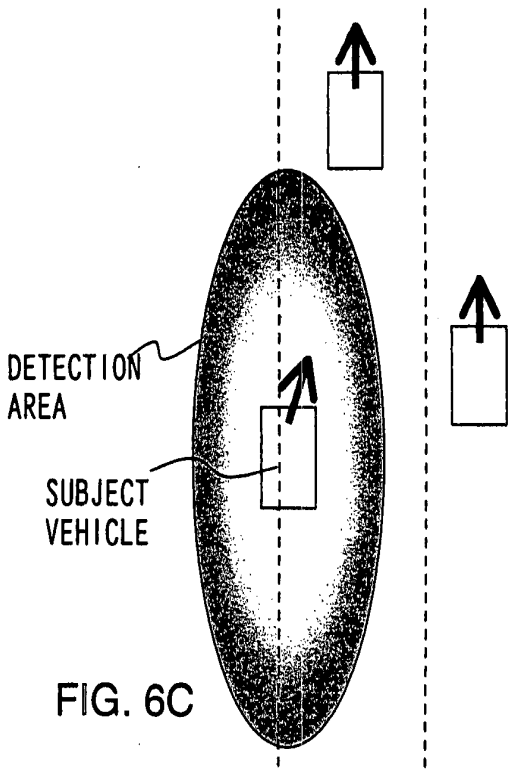


FIG. 6C

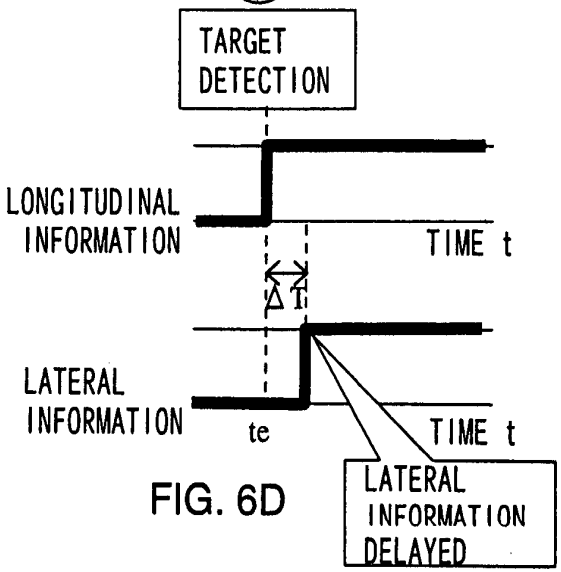


FIG. 6D

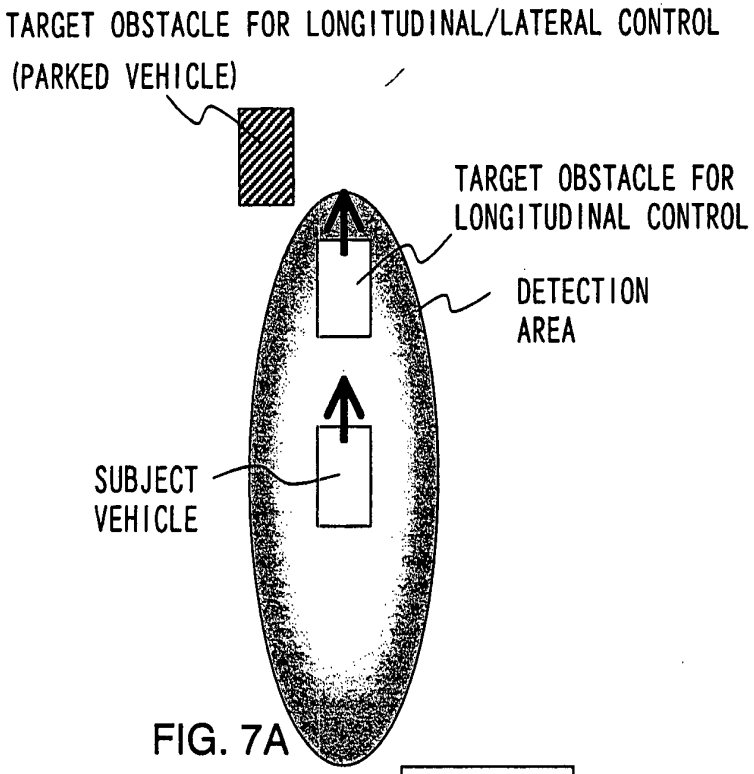


FIG. 7A

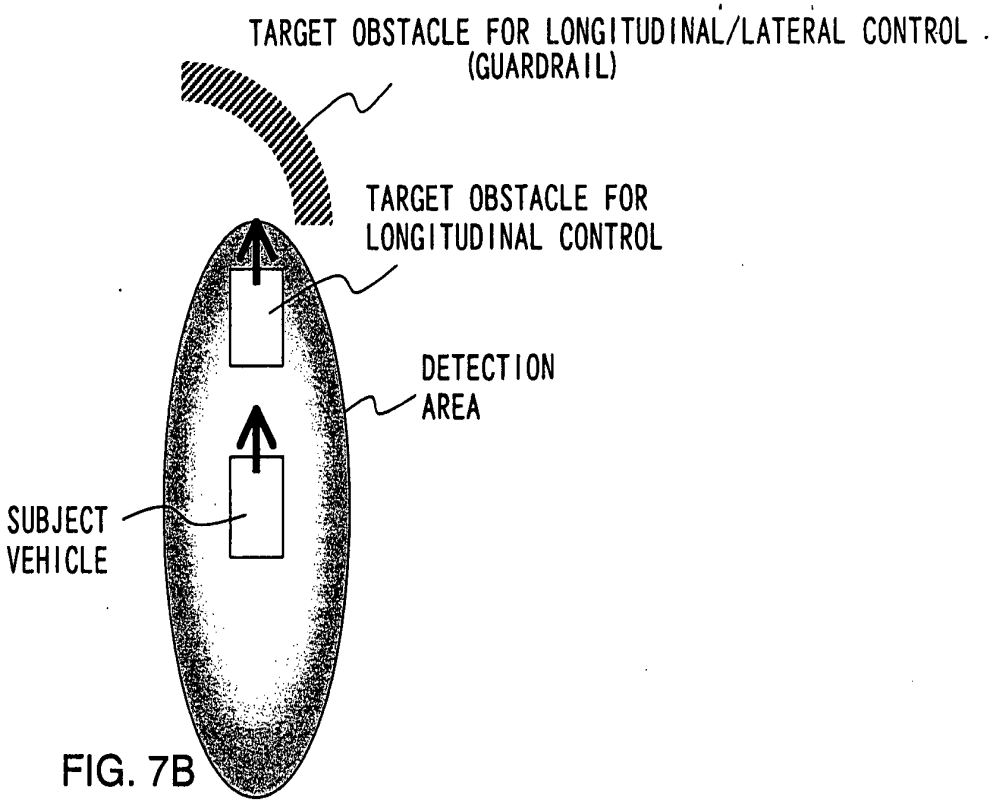


FIG. 7B

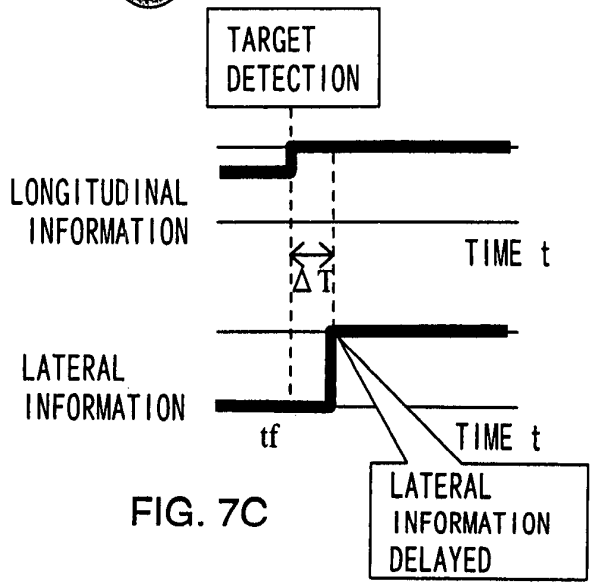


FIG. 7C

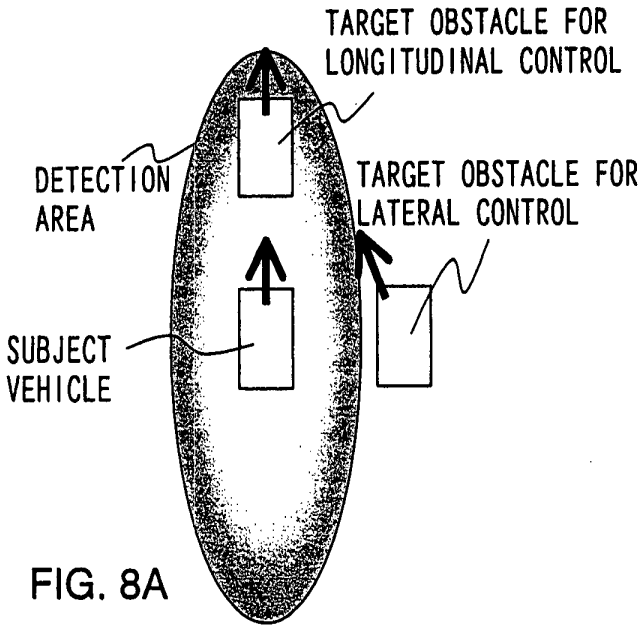

TARGET OBSTACLE FOR
LONGITUDINAL CONTROL
DETECTION
AREA
TARGET OBSTACLE FOR
LATERAL CONTROL
SUBJECT
VEHICLE

FIG. 8A

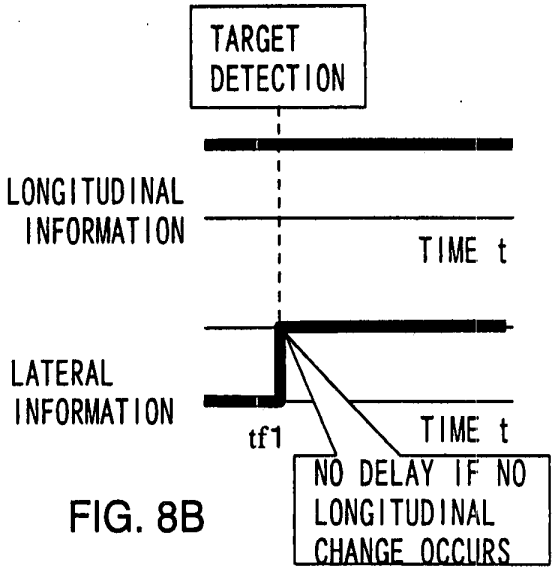

TARGET
DETECTION
LONGITUDINAL
INFORMATION
TIME t
LATERAL
INFORMATION
tf1
TIME t
NO DELAY IF NO
LONGITUDINAL
CHANGE OCCURS

FIG. 8B

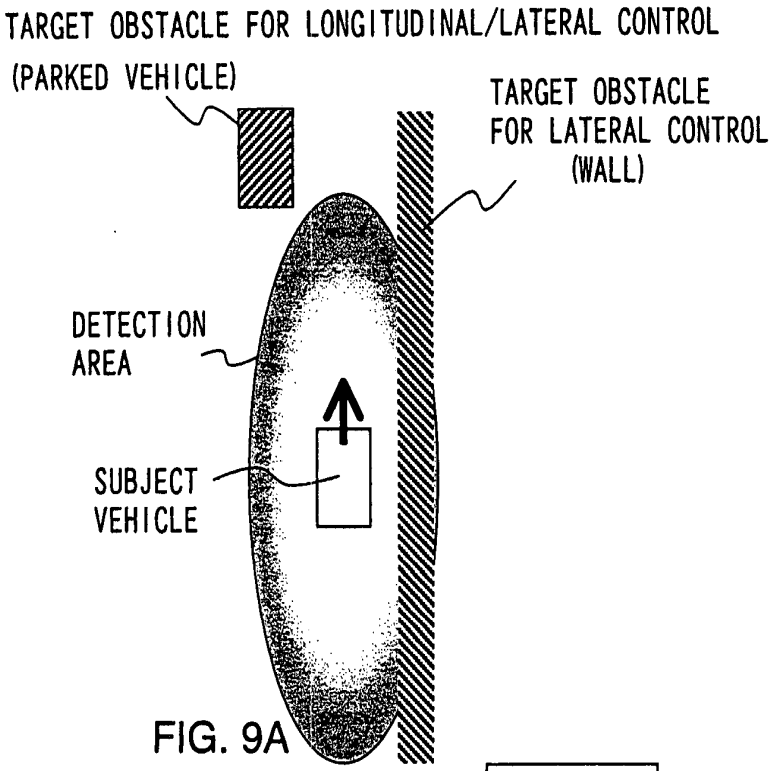


FIG. 9A

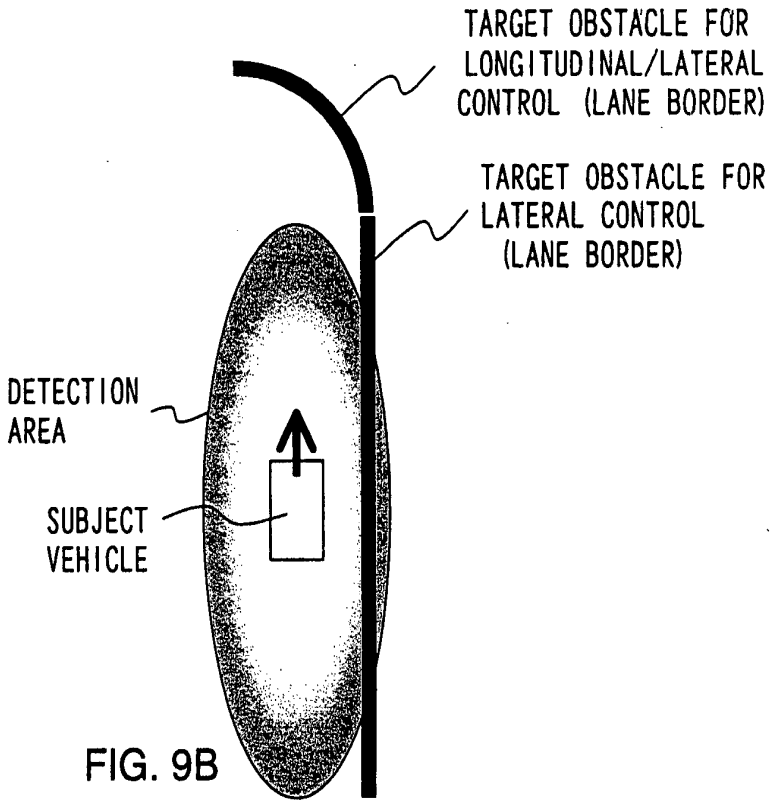


FIG. 9B

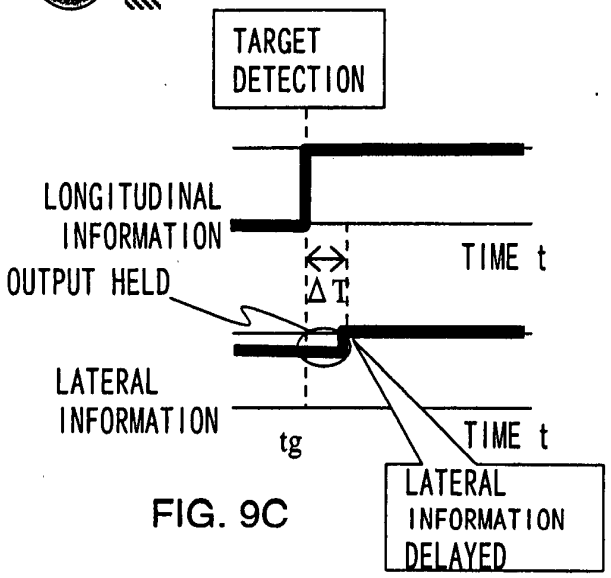


FIG. 9C

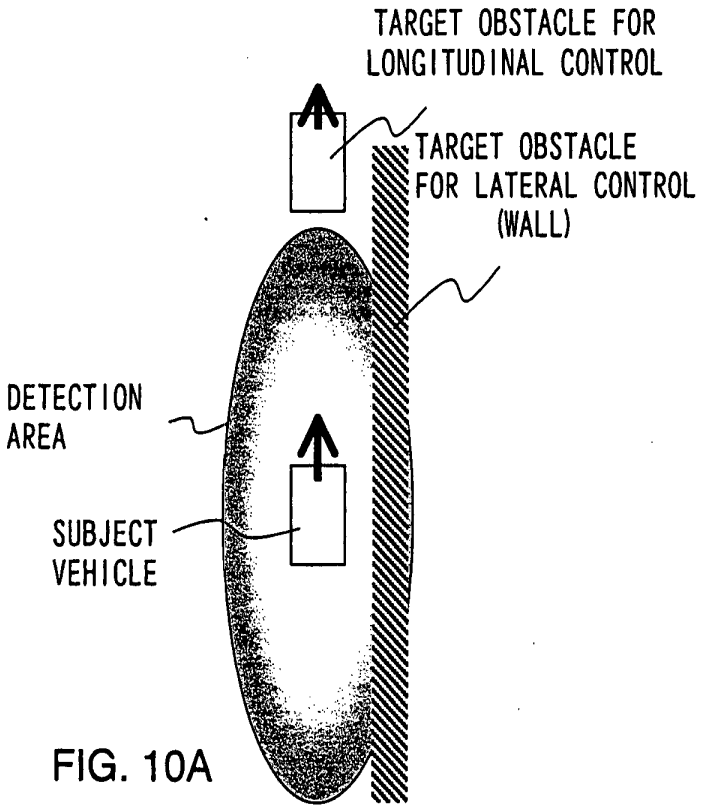


FIG. 10A

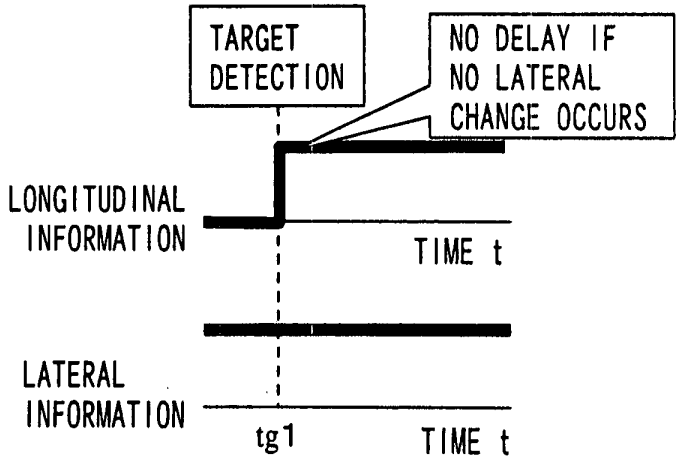


FIG. 10B

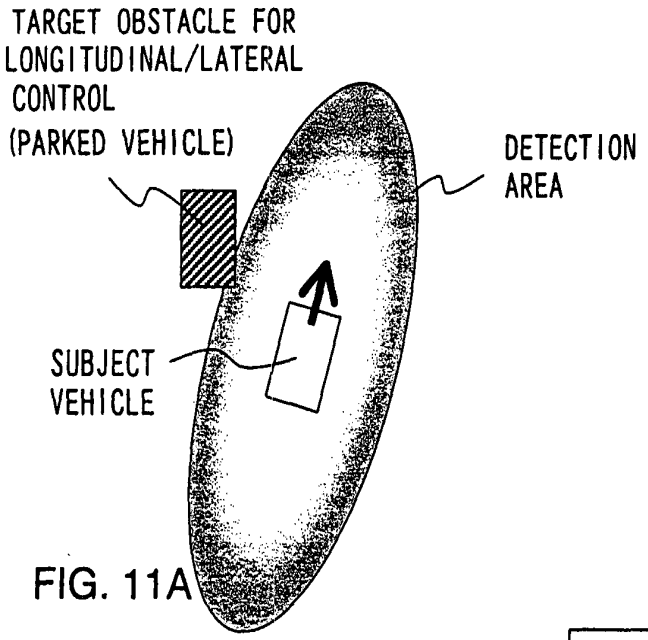


FIG. 11A

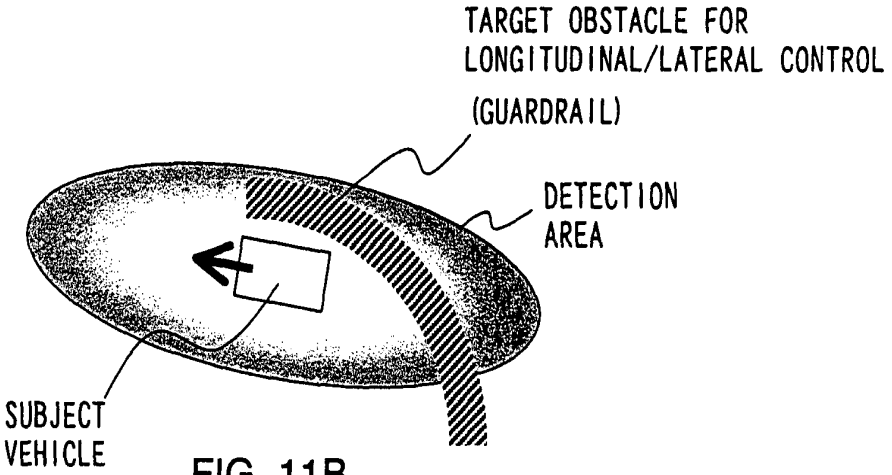


FIG. 11B

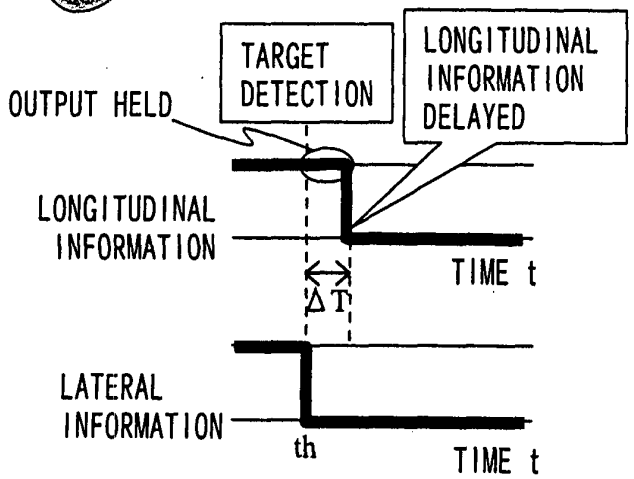


FIG. 11C

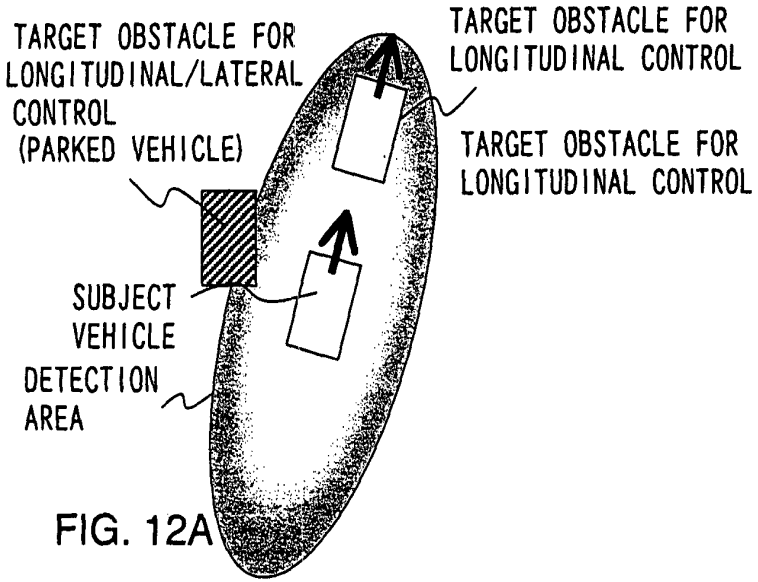


FIG. 12A

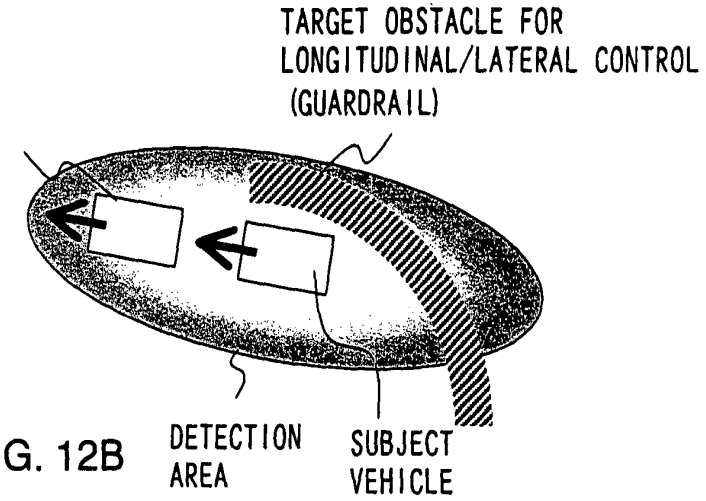


FIG. 12B

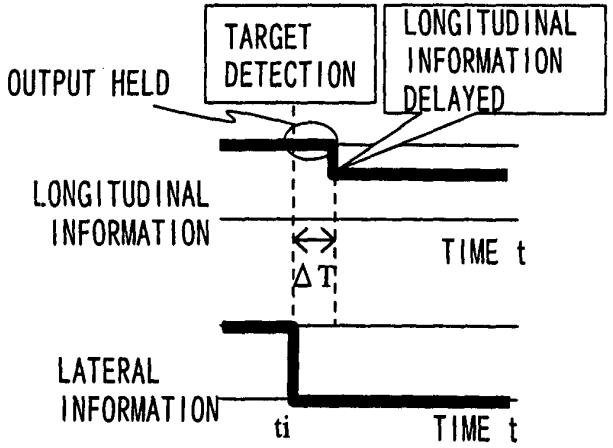


FIG. 12C

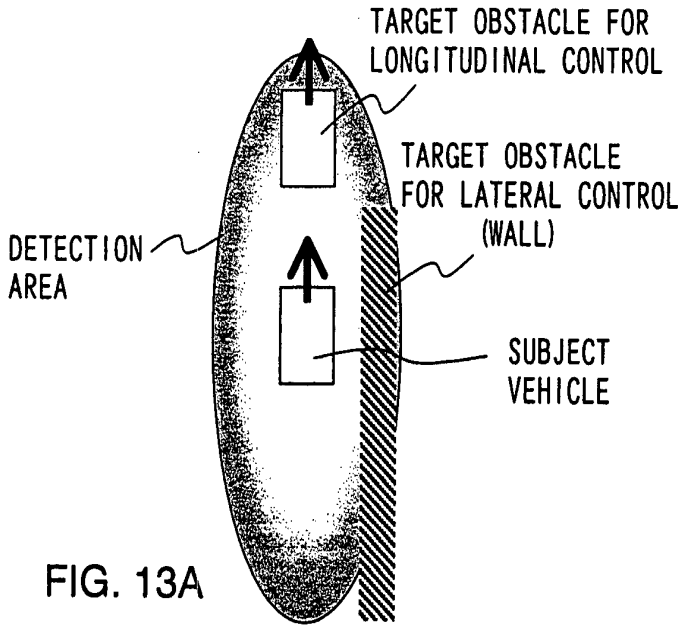


FIG. 13A

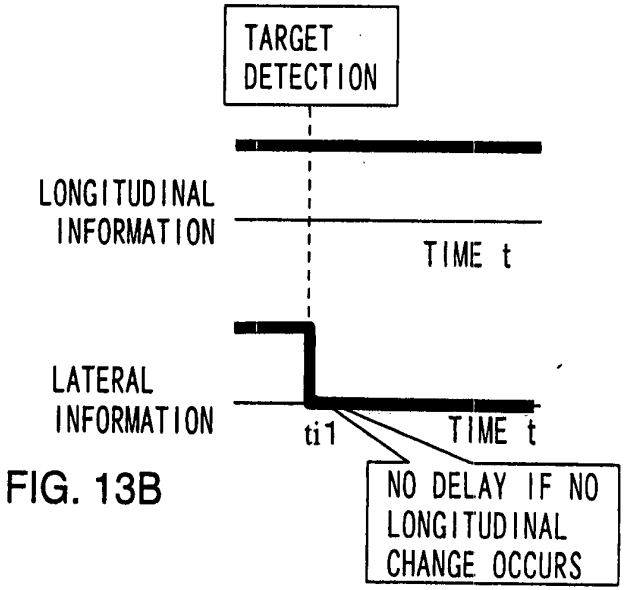


FIG. 13B

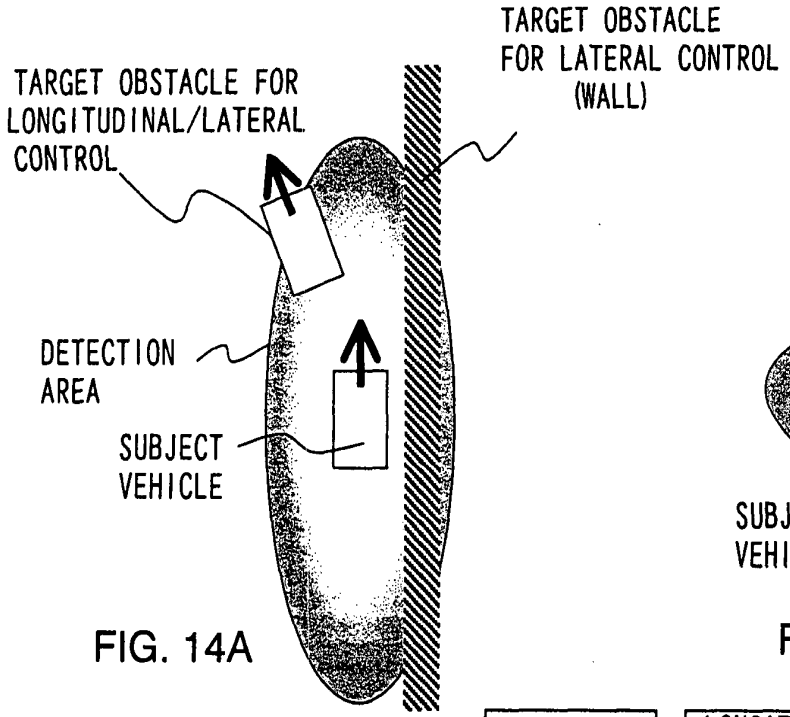


FIG. 14A

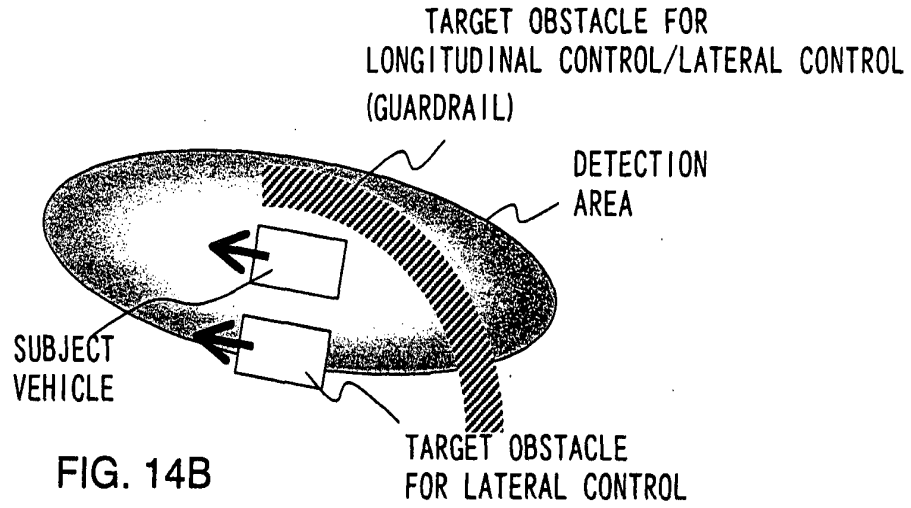


FIG. 14B

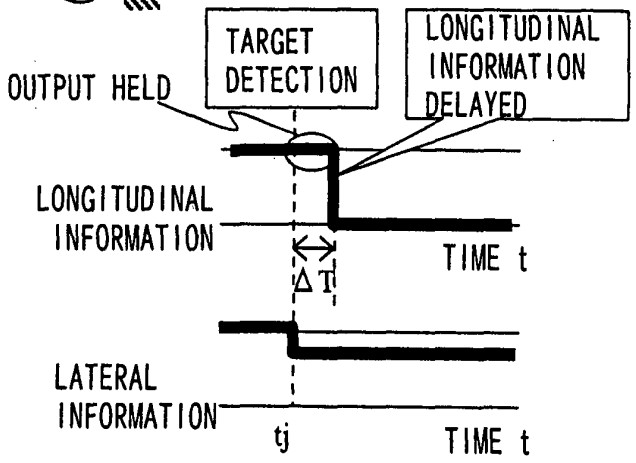


FIG. 14C

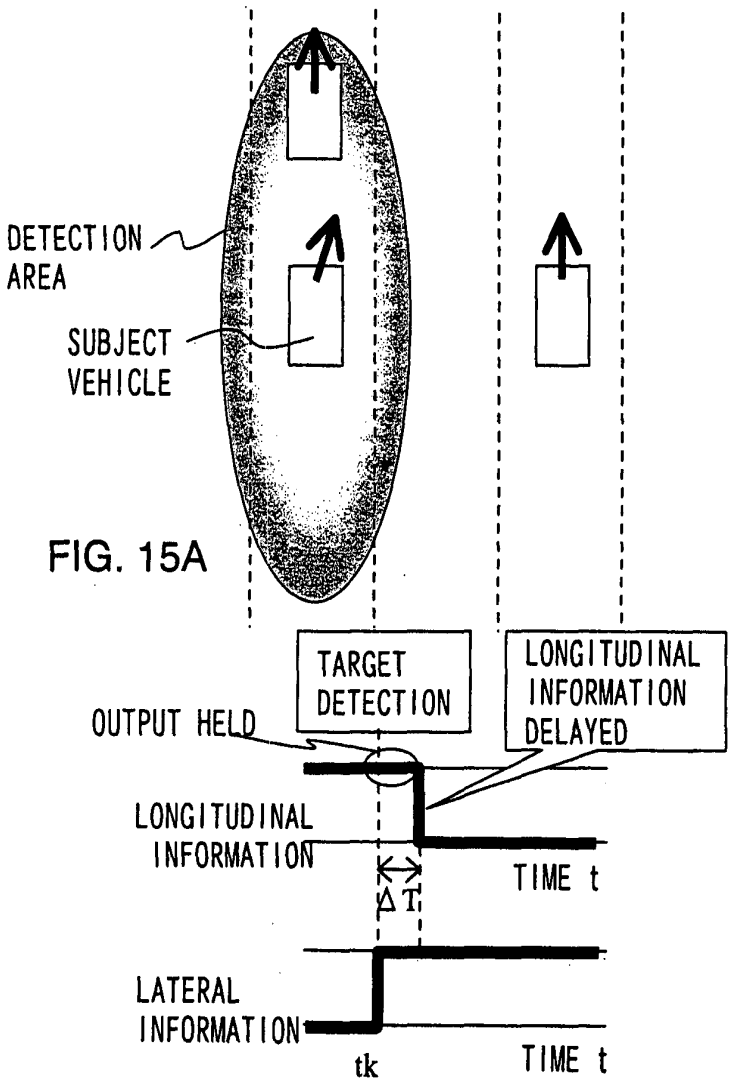


FIG. 15A

FIG. 15B

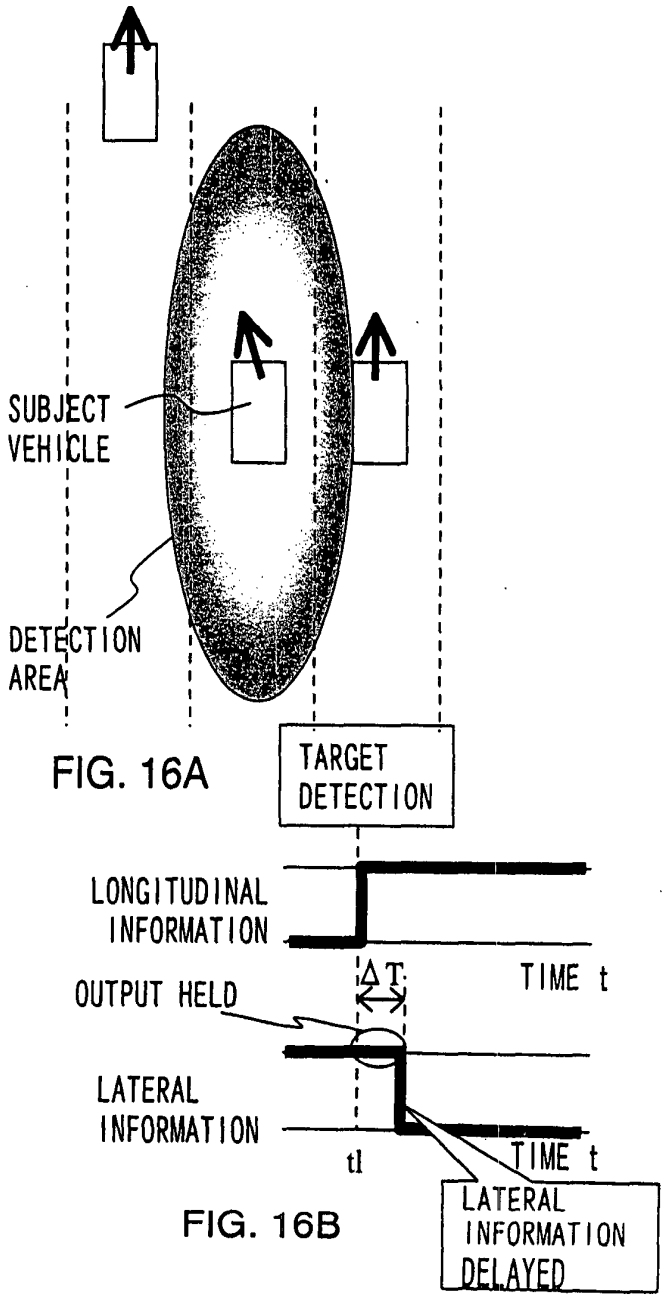


FIG. 16A

FIG. 16B

FIG. 17

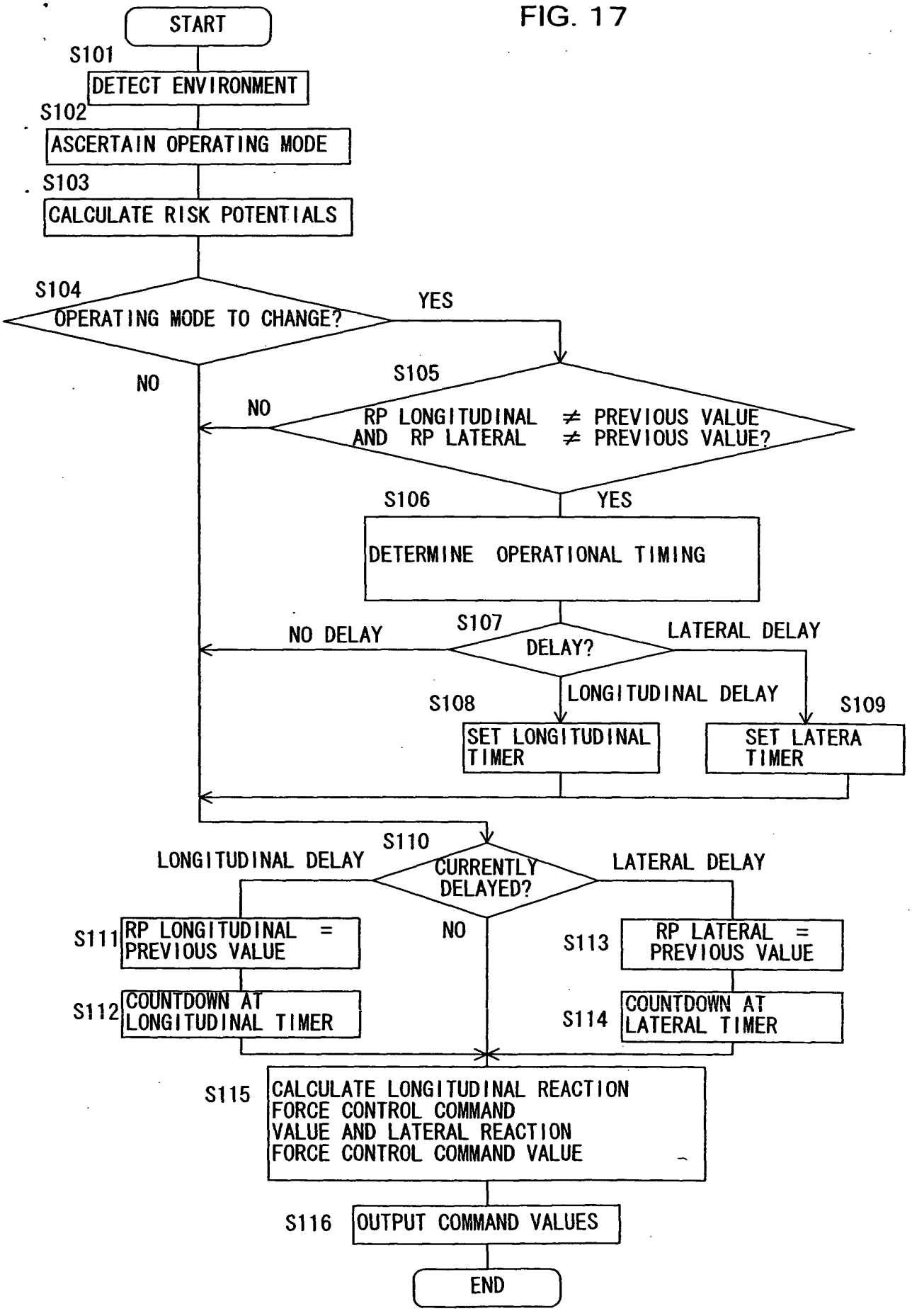

START
S101
DETECT ENVIRONMENT
S102
ASCERTAIN OPERATING MODE
S103
CALCULATE RISK POTENTIALS
S104
OPERATING MODE TO CHANGE?
YES
NO
S105
RP LONGITUDINAL ≠ PREVIOUS VALUE
AND RP LATERAL ≠ PREVIOUS VALUE?
NO
YES
S106
DETERMINE OPERATIONAL TIMING
S107
DELAY?
NO DELAY
LATERAL DELAY
LONGITUDINAL DELAY
S108
SET LONGITUDINAL TIMER
S109
SET LATERA TIMER
S110
CURRENTLY DELAYED?
LONGITUDINAL DELAY
LATERAL DELAY
NO
S111
RP LONGITUDINAL = PREVIOUS VALUE
S112
COUNTDOWN AT LONGITUDINAL TIMER
S113
RP LATERAL = PREVIOUS VALUE
S114
COUNTDOWN AT LATERAL TIMER
S115
CALCULATE LONGITUDINAL REACTION FORCE CONTROL COMMAND VALUE AND LATERAL REACTION FORCE CONTROL COMMAND VALUE
S116
OUTPUT COMMAND VALUES
END

FIG. 18

INFORMATION CONVEYANCE MODE BEFORE AND AFTER STATUS TARANSITION			OUTPUT TIMING FOR INFORMATION CONVEYANCE UPON STATUS TRANSITION				LENGTH OF DELAY
			LONGITUDINAL		LATERAL		
BEFORE	→	AFTER	SIMULTANEOUS	DELAYED	SIMULTANEOUS	DELAYED	
NO INFORMATION	→	LONGITUDINAL + LATERAL	○			○	△T
LONGITUDINAL + LATERAL	→	NO INFORMATION		○	○		W1△T
OTHERS			○		○		0

FIG. 19

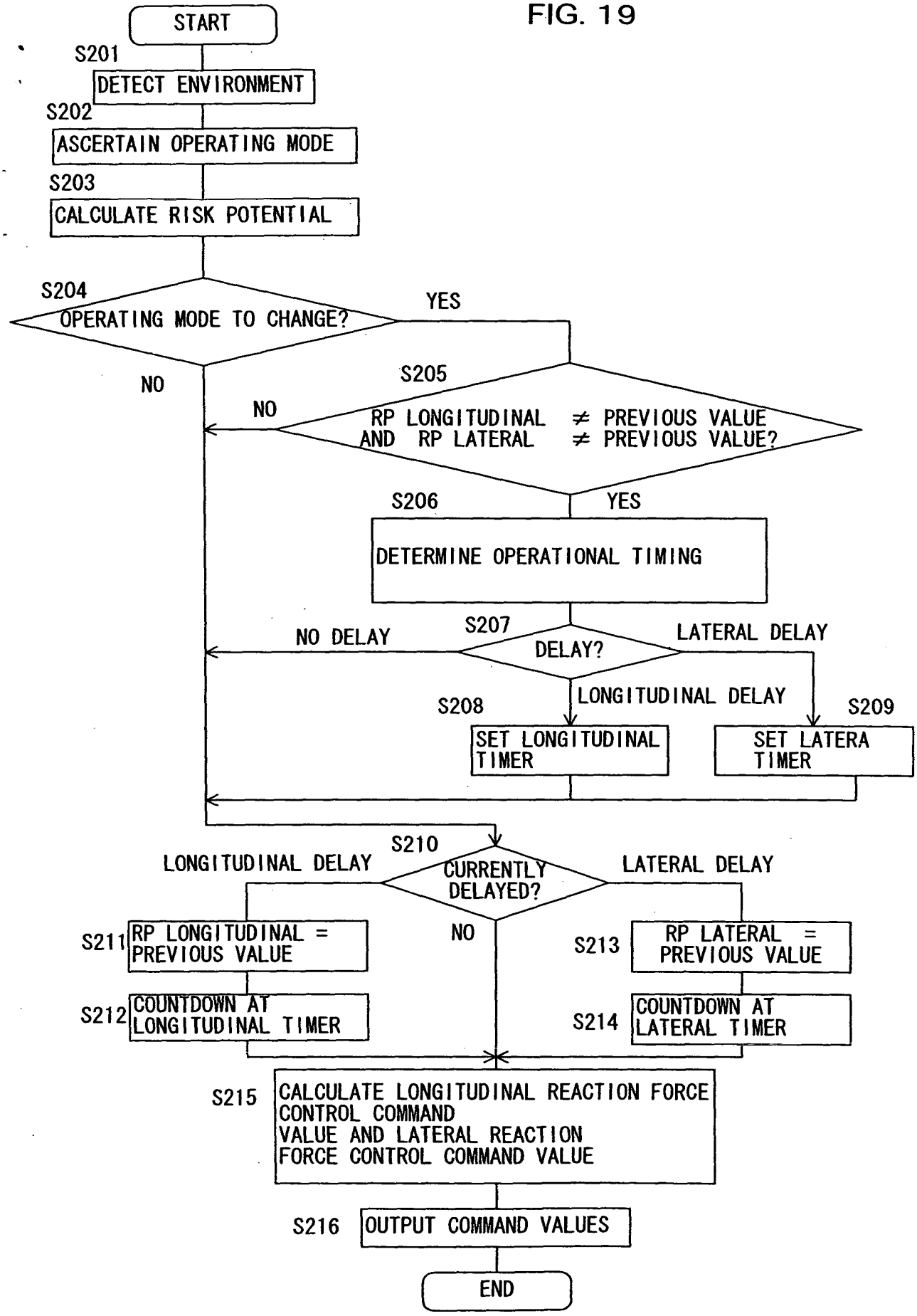

START
S201
DETECT ENVIRONMENT
S202
ASCERTAIN OPERATING MODE
S203
CALCULATE RISK POTENTIAL
S204
OPERATING MODE TO CHANGE?
YES
NO
S205
NO
RP LONGITUDINAL ≠ PREVIOUS VALUE
AND RP LATERAL ≠ PREVIOUS VALUE?
S206
YES
DETERMINE OPERATIONAL TIMING
S207
NO DELAY
DELAY?
LATERAL DELAY
LONGITUDINAL DELAY
S208
SET LONGITUDINAL TIMER
S209
SET LATERA TIMER
S210
LONGITUDINAL DELAY
CURRENTLY DELAYED?
LATERAL DELAY
NO
S211
RP LONGITUDINAL = PREVIOUS VALUE
S212
COUNTDOWN AT LONGITUDINAL TIMER
S213
RP LATERAL = PREVIOUS VALUE
S214
COUNTDOWN AT LATERAL TIMER
S215
CALCULATE LONGITUDINAL REACTION FORCE CONTROL COMMAND VALUE AND LATERAL REACTION FORCE CONTROL COMMAND VALUE
S216
OUTPUT COMMAND VALUES
END

FIG. 20

	INFORMATION CONVEYANCE MODE BEFORE AND AFTER STATUS TARANSITION			OUTPUT TIMING FOR INFORMATION CONVEYANCE UPON STATUS TRANSITION				LENGTH OF DELAY
				LONGITUDINAL		LATERAL		
	BEFORE	→	AFTER	SIMULTANEOUS	DELAYED	SIMULTANEOUS	DELAYED	
E	NO INFORMATION		LONGITUDINAL + LATERAL	○			○	△T
F	LONGITUDINAL		LONGITUDINAL + LATERAL	○			○	W1△T
G	LATERAL		LONGITUDINAL + LATERAL	○			○	W1△T
H	LONGITUDINAL + LATERAL		NO INFORMATION		○	○		W2△T
I	LONGITUDINAL + LATERAL		LONGITUDINAL		○	○		W3△T
J	LONGITUDINAL + LATERAL		LATERAL		○	○		W3△T
K	LONGITUDINAL		LATERAL		○	○		W4△T
L	LATERAL		LONGITUDINAL	○			○	W4△T
	OTHERS			○		○		0